A Temporal Analysis of Stormwater Quality in Dayton, OH

Dayton skyline, taken from Deeds St.

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The fountains at the connection of the Great Miami and the Mad River.

Introduction

The City of Dayton has a separate storm sewer system, which contains over 600 miles of storm sewer pipes and 21,000 storm drains, which carry rainwater to Dayton's rivers. Pollutants such as fertilizers, oil, and trash accumulate on impervious surfaces and can be washed into storm sewers and discharged into the rivers via outfalls. This can cause an influx in nutrients and other chemicals in our rivers, effecting wildlife, recreation, and aesthetics.

Objectives and Hypotheses

Study Aim:

- We analyzed historical data compiled by the City of Dayton Department of Water, with the goal of finding any significant trends in chemical concentrations.

Over time, chemical concentrations will:

(H_1) Show a consistent decreasing trend in many, if not all, measured chemical parameters on a river-wide scale

(H_2) Show relatively consistent concentration patterns in individual outfalls of interest.

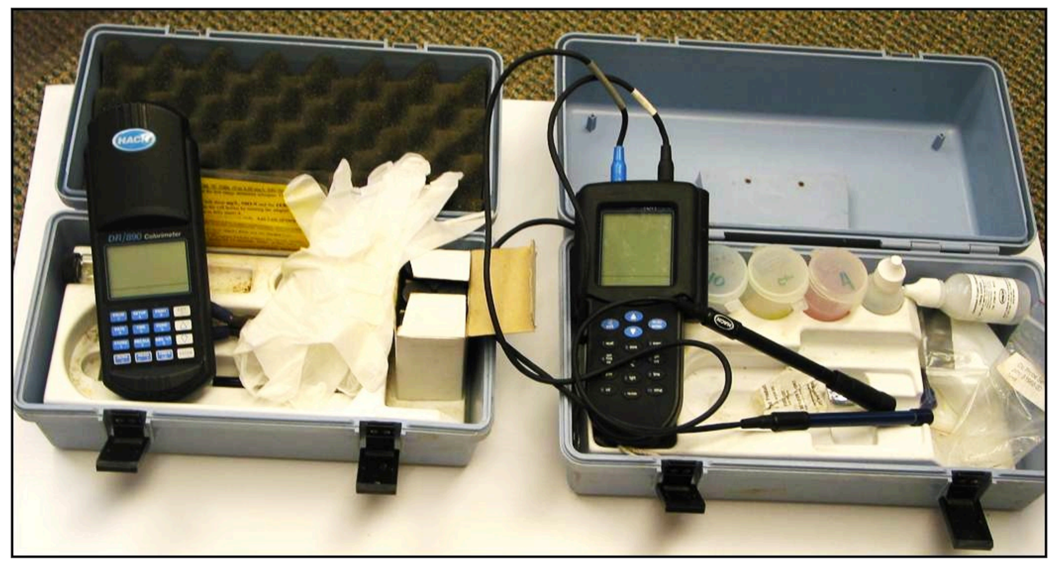

Fig 1: The two Hach meters used for water analysis in the field. Colorimeter (left) and pH/Conductivity/DO Probe (right).

Methods

Site Description:

Measurements were taken at the 560 outfalls within City of Dayton limits. Most were measured once each year, starting in 2000 and ending in 2015.

Data Collection:

Discharge from outfalls were measured for temperature, DO, pH, NH_3, NO_3, PO_4, and Cl_2 using a Hach Colorimeter (model DR/890) and a Hach pH/Cond/DO probe (Sension156).

Statistical Analyses:

- All analyses were conducted in R version 3.1.2 for Macintosh.

Results

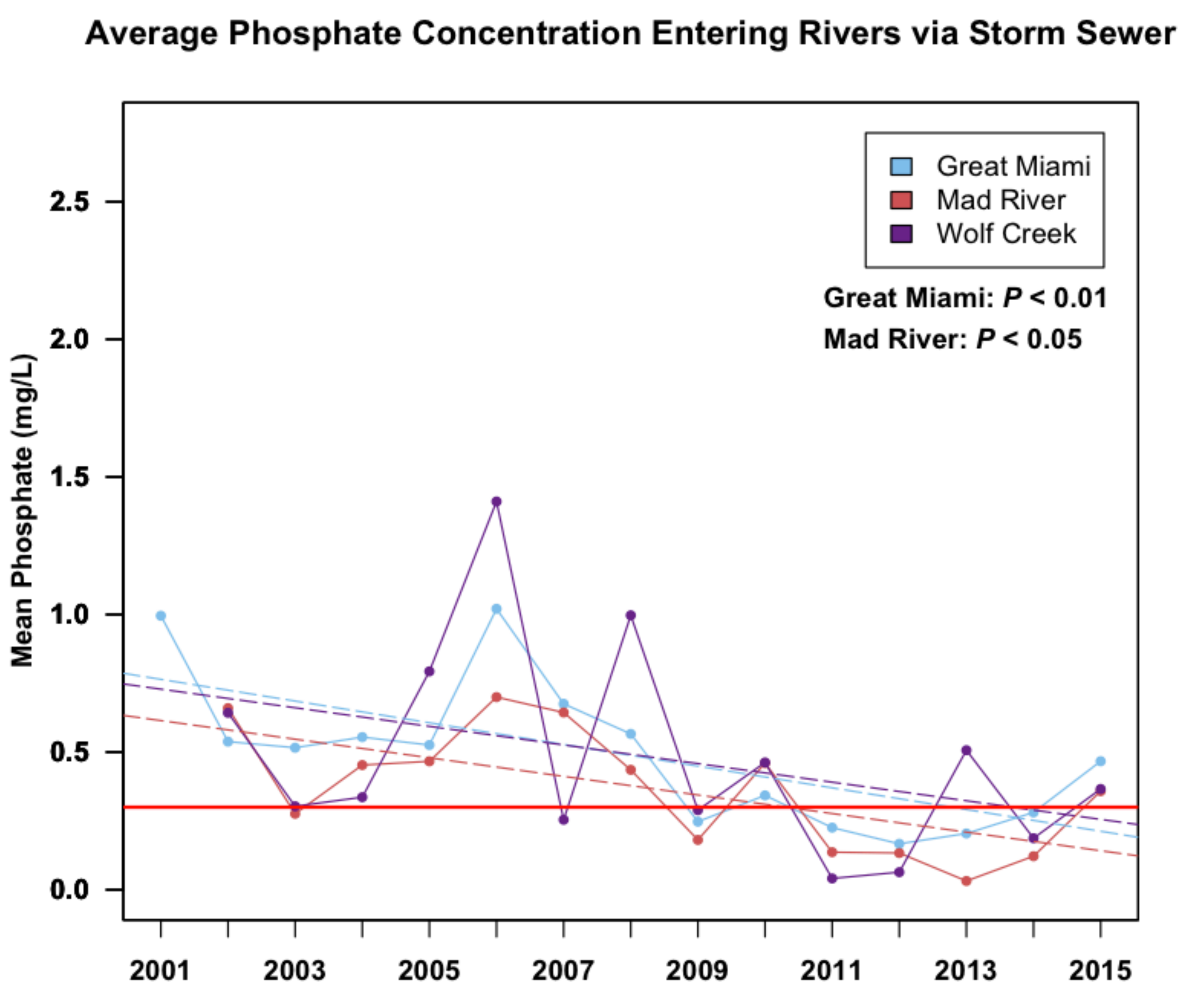

Fig 2: Mean phosphate concentrations of stormwater entering the Great Miami, Mad River, and Wolf Creek from outfalls for years 2001-2015. The City of Dayton action level for phosphate (0.3mg/L) is shown by the horizontal red line.

There is significant correlation between time and concentration of phosphate for both the Great Miami and Mad River at the river scale.

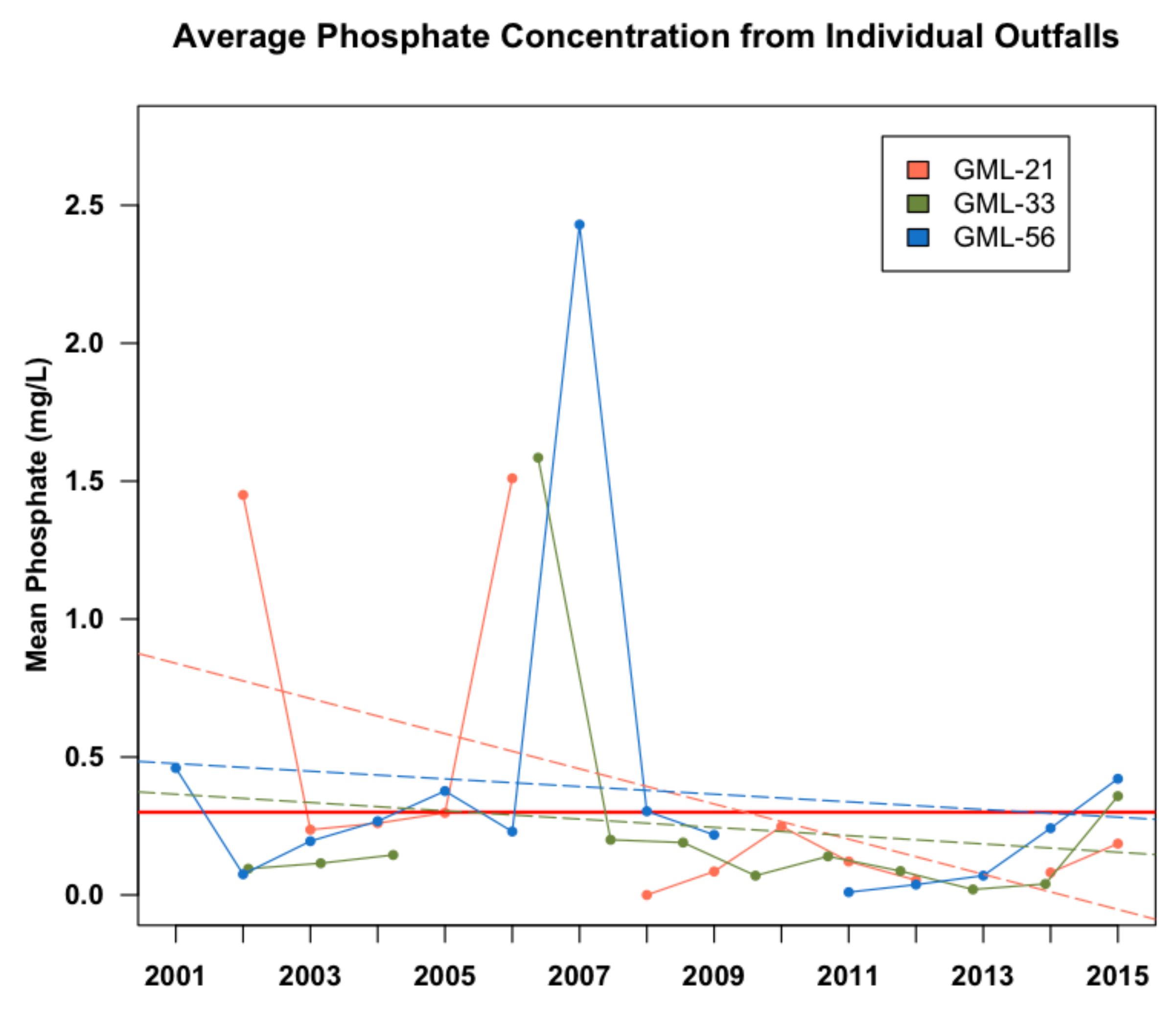

Fig. 3: Mean phosphate concentration of stormwater from outfalls GML-21, GML-33, and GML-56 for years 2001-2015. The City of Dayton action level for phosphate (0.3mg/L) is shown by the horizontal red line.

While there is no significant correlations between time and phosphate concentrations, later years show more values under the action level.

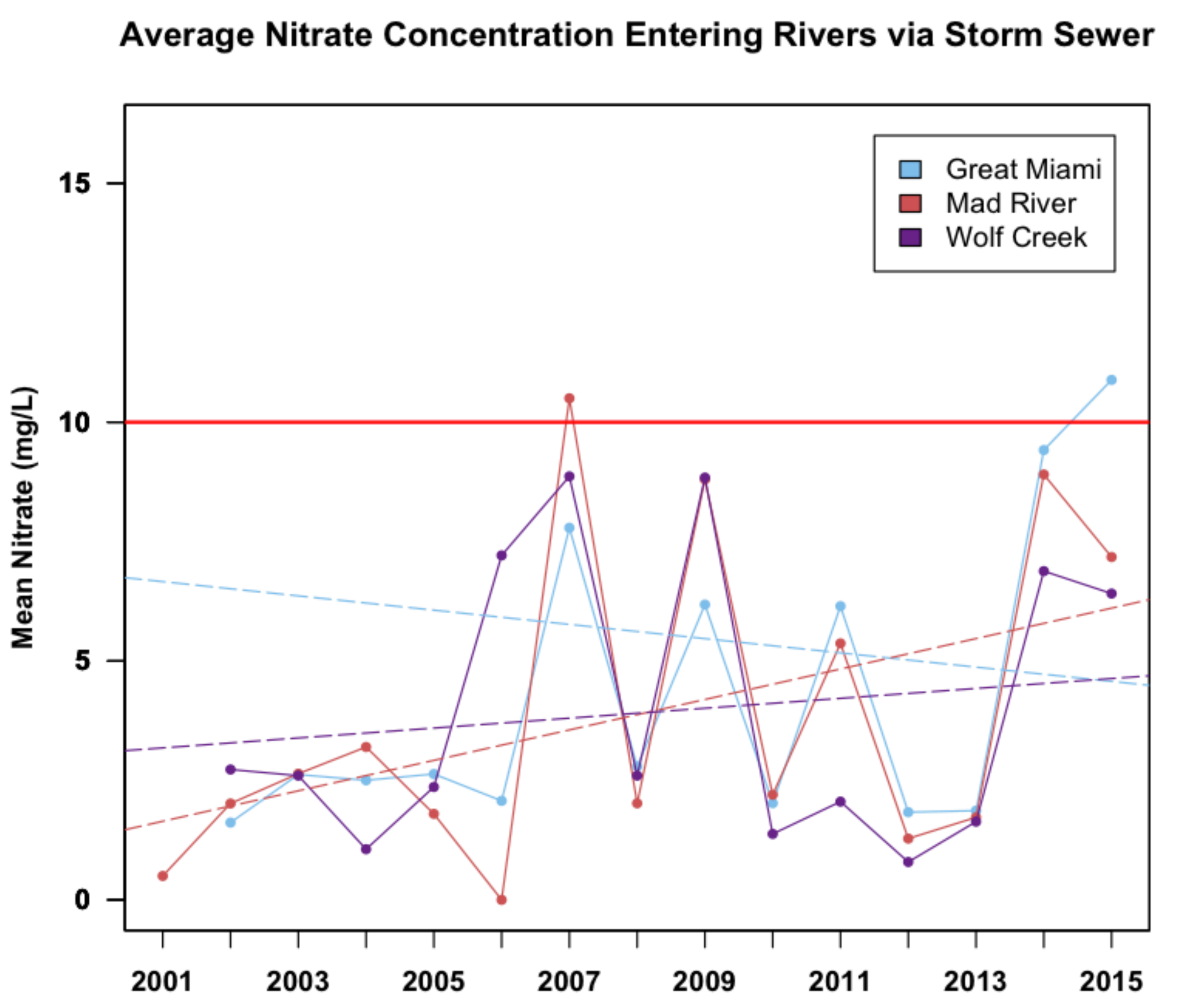

Fig. 4: Mean nitrate concentrations of stormwater entering the Great Miami, Mad River, and Wolf Creek from outfalls for years 2001-2015. The City of Dayton action level for nitrate (10mg/L) is shown by the horizontal red line.

There is no consistent patterns over time, but the concentrations seem to have similar high and low points through out the years at the larger river scale.

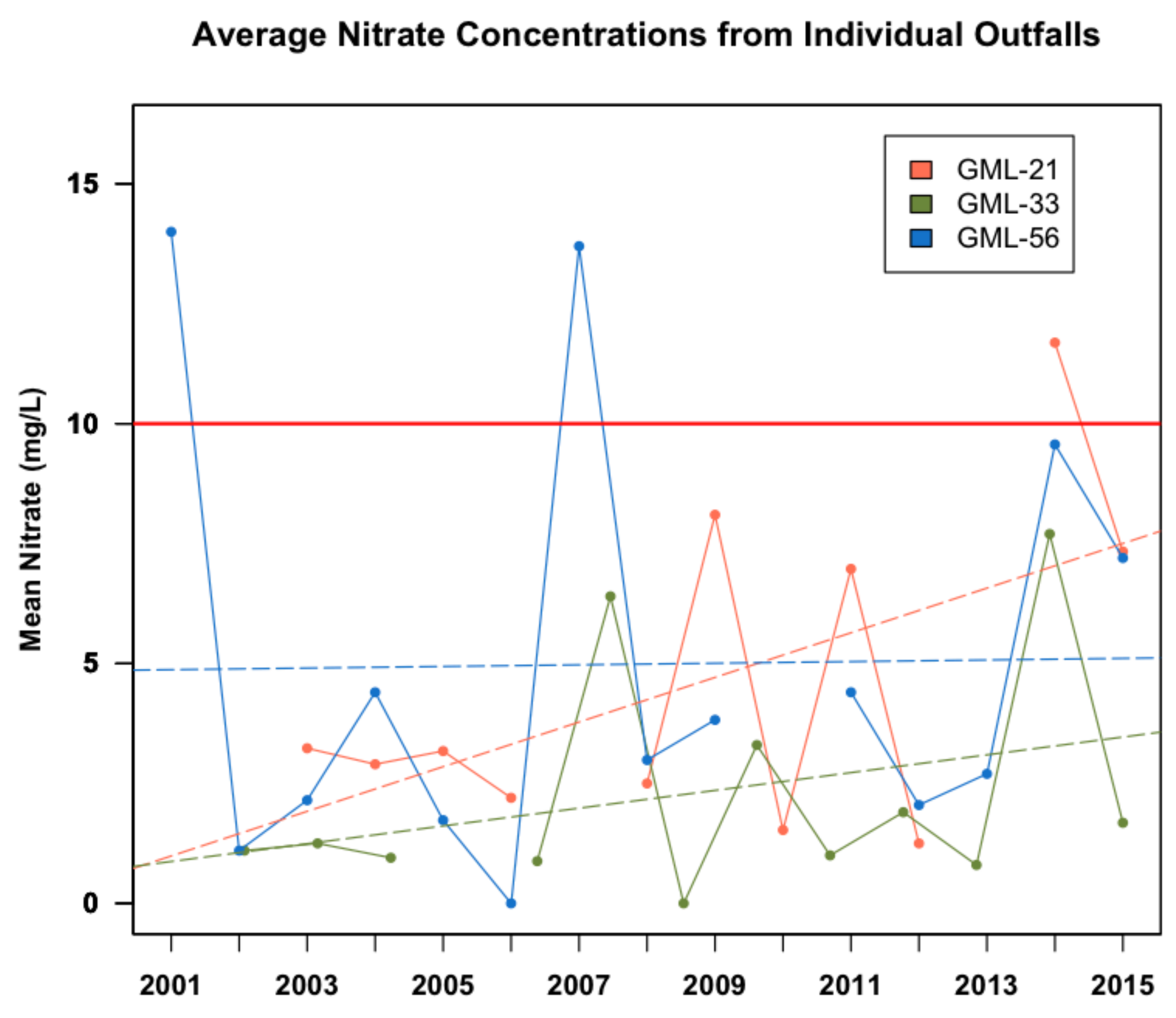

Fig. 5: Mean phosphate concentration of stormwater from outfalls GML-21, GML-33, and GML-56 for years 2001-2015. The City of Dayton action level for nitrate (10mg/L) is shown by the horizontal red line.

In these individual outfalls, the concentrations of nitrate are more variable than the concentrations means at the river scale.

Conclusions

River trends:

The Great Miami and the Mad River both showed a significant correlation between phosphate concentrations and time, in which levels decreased throughout the years (supporting H_1). While there were no significant correlations with nitrate, the rivers share similar patterned highs and lows in mean concentrations each year.

Outfall trends:

No significant correlations were found between concentrations and time, but there is a consistent pattern in phosphate (partially supporting H_2). Nitrate does not show any pattern.

Summary:

Lack of additional significance could be due to an insufficient data set, where the outfalls were not sampled the same number of times and where outliers are common. These findings can provide context for annual snapshot data, regarding stormwater regulations and monitoring. These results also show that the action levels held by the Department of Water are well placed as concentrations are commonly below them.

Fig.6: GML-56 outfall (left) and a standard street catch-basin (right).

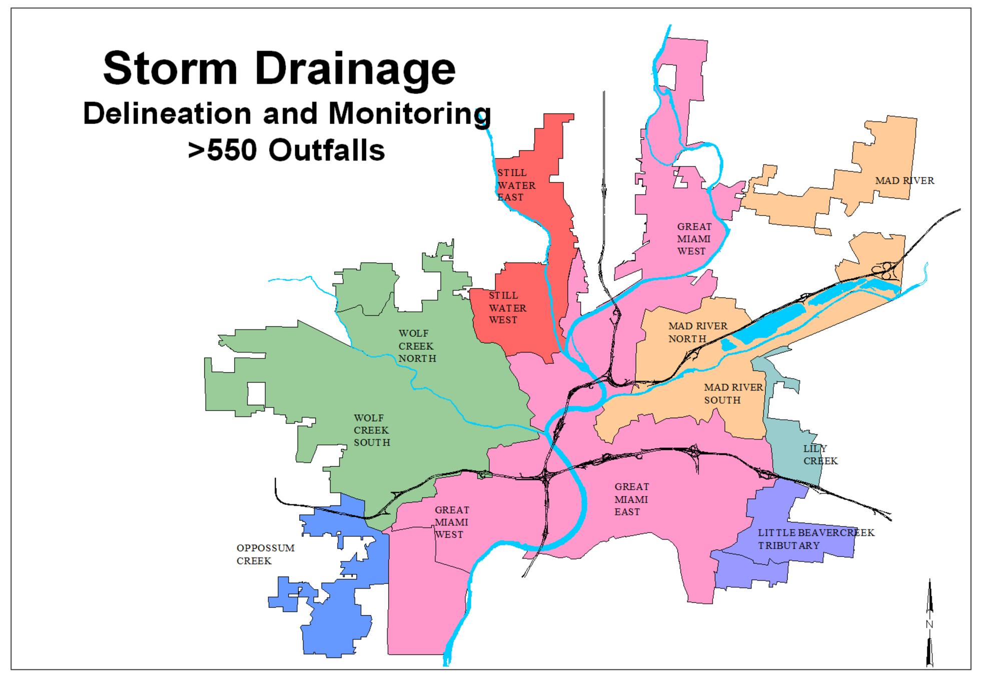

Fig. 7: A diagram of the storm drainage areas of Dayton.

References

All images and background information was provided by the City of Dayton Department of Water, Division of Environmental Management.

Acknowledgements

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